

207 TR-01-079

AFAMRL-TR-84-040



A MACHINE FOR WEIGHT-LIFT TESTING

NILSS M. AUME
AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY

AUGUST 1984

Approved for public release; distribution unlimited.

20100803 257

AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO 45433

NOTICES

When US Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Please do not request copies of this report from Air Force Aerospace Medical Research Laboratory. Additional copies may be purchased from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Federal Government agencies and their contractors registered with Defense Technical Information Center should direct requests for copies of this report to:

Defense Technical Information Center
Cameron Station
Alexandria, Virginia 22314

TECHNICAL REVIEW AND APPROVAL

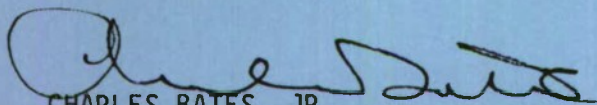
AFAMRL-TR-84-040

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

The voluntary informed consent of the subjects used in this research was obtained as required by Air Force Regulation 169-3.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER



CHARLES BATES, JR.
Director, Human Engineering Division
Air Force Aerospace Medical Research Laboratory

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS None		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFAMRL-TR-84-040			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION Air Force Aerospace Medical Research Laboratory		6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION		
6c. ADDRESS (City, State and ZIP Code) Wright-Patterson Air Force Base OH 45433			7b. ADDRESS (City, State and ZIP Code)		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State and ZIP Code)			10. SOURCE OF FUNDING NOS.		
			PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.
			62202F	7184	08
11. TITLE (Include Security Classification) A Machine for Weight-Lift Testing			WORK UNIT NO. 31		
12. PERSONAL AUTHOR(S) Aume, Nilss M.					
13a. TYPE OF REPORT Final		13b. TIME COVERED FROM 830601 TO 840201		14. DATE OF REPORT (Yr., Mo., Day) 1984 August	
				15. PAGE COUNT 44	
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB. GR.			
			Factor-X Strength testing Weight lifting		
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
<p>This report describes the design and building details of a weight lifting machine which is primarily intended for Factor X testing where only occasional use is foreseen and an expensive machine would not be cost effective. The machine allows one to select, in 10 pound increments, a weight from 40 to 200 pounds for lifting. The design of the machine allows the weight to move only up and down, eliminating any unwanted and hazardous motions.</p>					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS <input type="checkbox"/>			21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a. NAME OF RESPONSIBLE INDIVIDUAL NILSS M. AUME			22b. TELEPHONE NUMBER (Include Area Code) 513-255-2558		22c. OFFICE SYMBOL AFAMRL/HEG

PREFACE

The design of the Weight Lifting Machine was performed under Task 7184, Work Unit 71840831, "Biomechanics for System Design". The work was done between June 1983 and February 1984.

The design of the machine and the building of the prototype was accomplished by Nilss M. Aume, at the suggestion of Dr. Joe W. McDaniel.

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION	4
2. CARRIAGE	5
3. STATIONARY FRAME	8
4. ASSEMBLY OF MACHINE	11
4.1 Carriage Assembly	11
4.2 Frame Assembly	16
APPENDIX I: DRAWINGS FOR PARTS	25
APPENDIX II: EXTRACTS FROM MEPCOM REG 40-3 .	35

LIST OF ILLUSTRATIONS

Figure	<u>Page</u>
1 Welding of Carriage	12
2 Carriage Welding Details	13
3 Installation of Bearings, Top View	14
4 Sketch of the Frame of the Weight Lifting Machine .	15
5 Installing the Bottom Rail	16
6 Measuring the Outside Distance over the Small Bearings	17
7 Installing Gussets on Top Cross-member	18
8 Installing Brackets on Back Braces	19
9 Installing 90 Degree Brackets on the Bottom Rails .	20
10 Arrangement of Components on the Platform, Viewed from Above	21
 A1 Top and Bottom Strips	 26
A2 Side Strips	26
A3 Corner Strips	27
A4 Support Plates	27
A5 Bearing Holders	28
A6 Handles	29
A7 Tongue	30
A8 Channel Plate of Top Connector	31
A9 Top Connector Plate	32
A10 Connector Body	33
A11 Bottom Connector Plate	34

LIST OF TABLES

Table	Page
1 List of Carriage Parts	7
2 List of Standard Unistrut Parts	9
3 List of Other Parts for the Frame	10

1. INTRODUCTION

At the MEPS (Military Entrance Processing Stations) all Air Force and Army recruits take a physical strength test to demonstrate abilities to perform jobs involving heavy physical demand. The weight lift machines used in this test were designed by AFAMRL to satisfy the needs of continuous, high volume testing at the MEPS. There are locations in the Air Force where this testing is needed on an infrequent basis and where it is not economically feasible to send the person to be tested to the nearest MEPS. Such locations include reserve units, whose recruits do not go through the MEPS; people on active duty who want to change from a light to a heavy job; people who have recovered from an injury or illness and need to be recertified to return to the job. At these locations a test machine is needed which is less expensive and can be constructed and maintained locally by limited shop facilities. Such a design was achieved by selecting standard hardware components for the stationary frame of the machine and designing a simple carriage with commercially available weights for lifting. The carriage travels in the rails on ball bearings, so that it moves with a minimum of friction. As designed, the weight of the carriage and handle assembly alone is 40 pounds, so that this is the least weight that can be lifted. Additional 10 pound weights can be attached to the carriage, so that any weight, in 10 pound increments, can be lifted up to a maximum of 200 pounds. The machine is so designed that movement of the carriage is constrained to the vertical direction. Downward motion of the carriage assembly must be controlled to prevent a free fall.

While AFAMRL used Unistrut brand components (and some other brands are mentioned) in the construction of the weight lifting machine, this does not constitute an endorsement of this product; there may be components produced by other manufacturers that could be used equally well.

2. CARRIAGE

All parts required for the construction of the carriage are listed in Table 1. Parts C1 through C8 (parts for the carriage are prefixed with a "C", and parts for the frame are prefixed with an "F") are adequately described by their drawings (Figures A1 through A7). The drawings are given in Appendix I, together with some parts for the frame.

Parts C9 and C10. The large bearings travel inside the channel of the main uprights and allow moving the carriage with a minimum of friction, and keep the carriage from tilting back and forth. Our design used prelubricated double shielded bearings, both the large (C9) and the small (C11), in order to prevent dirt from getting inside the bearings. We used "Nice" bearing 3020DS for the large bearings.

The outside diameter (O.D.) of this bearing was selected so that it would fit inside the main uprights of the machine. If material with other dimensions is used, the bearing clearance should be $1/32$ to $1/8$ inches. The bearings must not be binding; on the other hand, too loose a fit causes the carriage to become wobbly. The size of the bore of the bearing (inside diameter) also determines the diameter of the bolt to be used and also the diameter of the hole to be drilled in the bearing holders. The bolt must be long enough to go through the bearing holder plus the side strip, and hold the bearing, a flat and a lock washer, and a nut. Using smaller bore bearings and smaller diameter bolts should be avoided, as the bolts have to withstand fairly large forces during the lifting.

Parts C11 and C12. The purpose of the small bearings is to prevent the carriage from turning sideways and rubbing against the main uprights. Bearings and bolts of the prescribed size should be used, whether Unistrut or some other brand components are used. Our design used "Nice" bearings 3003DS. The small

bearings should be installed on the side of the holders facing the subject. The front part of the main upright is smooth, while on the back there are places where the channels have been welded together, which causes the motion of the carriage to be jerky, and this could be distracting to the person doing the lifting. All bearing bolts, and also the tongue bolt (C13), should be of No. 5 or higher strength (not to be confused with bolt size). Such bolts are normally sold only in specialized fastener stores.

Part C13. A bolt of strength 5 was used, with a self-locking nut which will stay in place without having to tighten the nut against the carriage.

Parts C14 and C15. Our design used attachable weights manufactured by Marcy Gym Equipment Company of Glendale CA. Substitutes are not recommended as they may require extensive design changes. The inside hole of these weights happens to fit the inner uprights (Unistrut P7000). The inside of the carriage has been designed to fit around these weights with some clearance. The weight selection holes in the tongue are dimensioned to match the holes in the weights. The weights are sold in sets of 22, so there will be 6 weights left over, which can be used as replacements should a weight be broken during use.

Marcy also sells a weight select pin, which is designed with a ball detent so that, once pushed through the tongue, it will not slide and fall out. Substitutes should not be used. We recommend that a spare pin be purchased.

Part C16. We used adhesive-backed bicycle handle-bar cloth tape of a bright red color to give the handles better visibility. This tape should be replaced if it becomes dirty, greasy or worn.

Part C17. The cover, intended to obscure the number of weights being lifted from the examinee's view, can be made from sheet aluminum or opaque plastic, 12 inches by 16 inches.

TABLE 1.
LIST OF CARRIAGE PARTS.

Part	Name	Quant.	Remarks
C1.	Top strips	2	Fig. A1.
C2.	Bottom strip	1	Fig. A1.
C3.	Side strips	4	Fig. A2.
C4.	Corner strips	4	Fig. A3.
C5.	Support plates	2	Fig. A4.
C6.	Bearing holders	4	Fig. A5.
C7.	Handles	2	Fig. A6.
C8.	Tongue	1	Fig. A7.
C9.	Large bearings	4	7/16 bore, 1 3/8 OD, 7/16 wide
C10.	Large bearing bolts	4	7/16 dia, 2 1/2 long, with flat washer, lock washer, and nut
C11.	Small bearings	4	5/16 bore, 7/8 OD, 9/32 wide
C12.	Small bearing bolts	4	5/16 dia, 1 3/4 long, with flat washer, lock washer, and nut
C13.	Tongue bolt	1	1/2 dia, 7 1/2 long, with self-locking nut
C14.	Weights	16 *	10 pounds each, Marcy Part Number 101740
C15.	Weight attaching pin	2	One plus a spare
C16.	Handle wrap	2	One plus a spare
C17.	Cover	1	12 x 16 inch, sheet aluminum or plastic; plus 4 screws (6-32, 1/2 in. long) and nuts.

* Also see explanation in text for Part C14.

3. STATIONARY FRAME

The majority of the parts of the stationary frame are standard Unistrut components. All Unistrut components are listed in Table 2. The remainder are listed in Table 3.

The platform consists of two 3/4 inch pieces of plywood, glued together to form one 1 1/2 inch thick piece.

The main uprights, which guide the carriage, should be cut to 8 foot length if the ceiling height in the intended location will permit this. Otherwise, the main uprights have to be cut so that the machine will fit under the ceiling (subtract 8 inches from ceiling height; this allows a small clearance). Initially the inner uprights, which guide the tongue, should be cut to the same length as the main uprights, and then, after the rest of the machine is assembled, shortened as described in "Assembly of Frame". Note that the inner uprights are not the same length as the main uprights (the inner uprights are shorter).

Cut two 4-foot lengths from one of the single channels (P1000) for bottom rails. Cut 20 inches from the other for the top cross-member. Cut the remainder of the second channel into two parts of equal length (50 inches) for the back braces. It is important to deburr and smooth off the cut ends.

Drill holes in the bottom rails for attaching them to the platform. Each rail has 5 holes drilled in it, 1/4 inch diameter, spaced 11 inches center-to-center, and with the end holes about 2 inches from the ends of the rails. The holes should be well centered in the rails to facilitate access to the screws that will hold the rails and the platform together.

The parts for the two connectors have to be produced in a machine shop; all other parts are used in their commercially available form.

TABLE 2.
LIST OF STANDARD UNISTRUT PARTS.

Unistrut Part Number	Description	Quant	Catalog Page *
P1001C	Double channel, 10 ft, 1 5/8 width	2	13
P1000	Single channel, 10 ft, 1 5/8 width	2	13
P7000	Single channel, 10 ft, 1 3/16 width	2	101
P2484 **	90 deg. gussett	2	35
P1346	90 Deg. bracket	2	35
P2101	30 deg. bracket	2	38
P2108	60 Deg. bracket	2	38
P1010	1/2 - 13 nut	23	27
HHCS050119EG	Hex head cap screw, 1/2 - 13, 1 3/16 long	23	29
P2459-36	36 in. cross brace	1	50

* Unistrut General Engineering Catalog No 9.

** This is a replacement for P1331 and P1332 which are listed on page 35.

TABLE 3.

LIST OF OTHER PARTS FOR THE FRAME.

1. Hex head screws, 1/4 - 20, 1 in. long, 2 pieces.
2. Button head screws, 10 - 32, 3/8 in. long, 4 pieces.
3. Pan head sheet metal screws, No 8, 1 in. long, 3 pieces.
4. Flat head screws, 10 - 32, 1/2 in. long, 4 pieces.
5. Rubber, 35 durometer, 3 in. x 4 in., 1/2 in thick, 8 pieces.
6. Plywood, 3 ft. x 6 ft., 3/4 in. thick, 2 pieces.
7. Top connector, (Figures A8, A9, A10; parts F1, F2, F3).
8. Bottom connector (Figures A10 and A11; parts F3 and F4).
9. Flat-head screws, 1/4 - 20, 1 1/4 in. long, with nuts and flat washers, 10 pieces.
10. Star-type lockwashers, 1/2 inch inside diameter, 23 pieces, to be used with Unistrut bolts.

4. ASSEMBLY OF MACHINE

4.1. Carriage Assembly. The parts of the carriage must be welded together as shown in Figures 1 and 2. Weld all around wherever two parts join. Check that the handles do not have any sharp places from the bending operation; if there are, file them smooth. The handles have to be placed through both the front and the back corner strips. Note that the 1/2 inch holes in the two top strips are at the top the carriage. In Figure 2, note the placement of the bearing holders (C6) with respect to the side plates (C3) - there must be enough space for the small bearings (C11). The bottom strip is on the same side as the handles. The bottom of the back is left open to provide access for the weight select pin. After welding, the through holes for the large bolts (in the bearing holders) have to be drilled through the side strips - this assures alignment for the bolts. Also, check the space between the ends of the handles - it should be 18 inches (plus/minus a quarter inch). If necessary, cut off some of the pipe, keeping the open space centered on the carriage. Clamp the cover (C17) in place (on the examinee's side of the carriage, between the handles) and drill 4 holes (9/64 inch drill bit) through it and the top and bottom strips - the exact location is not important. For the convenience of the following assembly steps, you may wish to install the 6-32 screws later.

Paint the carriage before any further assembly, as paint or any other foreign matter must not be allowed to get into the bearings. Also, check all bearings before installation to make sure that they work freely and smoothly.

Next, place a large bearing (C9) on a large bolt (C10), then a lockwasher. Insert the bolt in the hole of the bearing holder, install a flat washer and a nut, and tighten (see Figure 3). Repeat for the remaining three large bearings. The order of assembling the small bearings (C11) is the same. The small

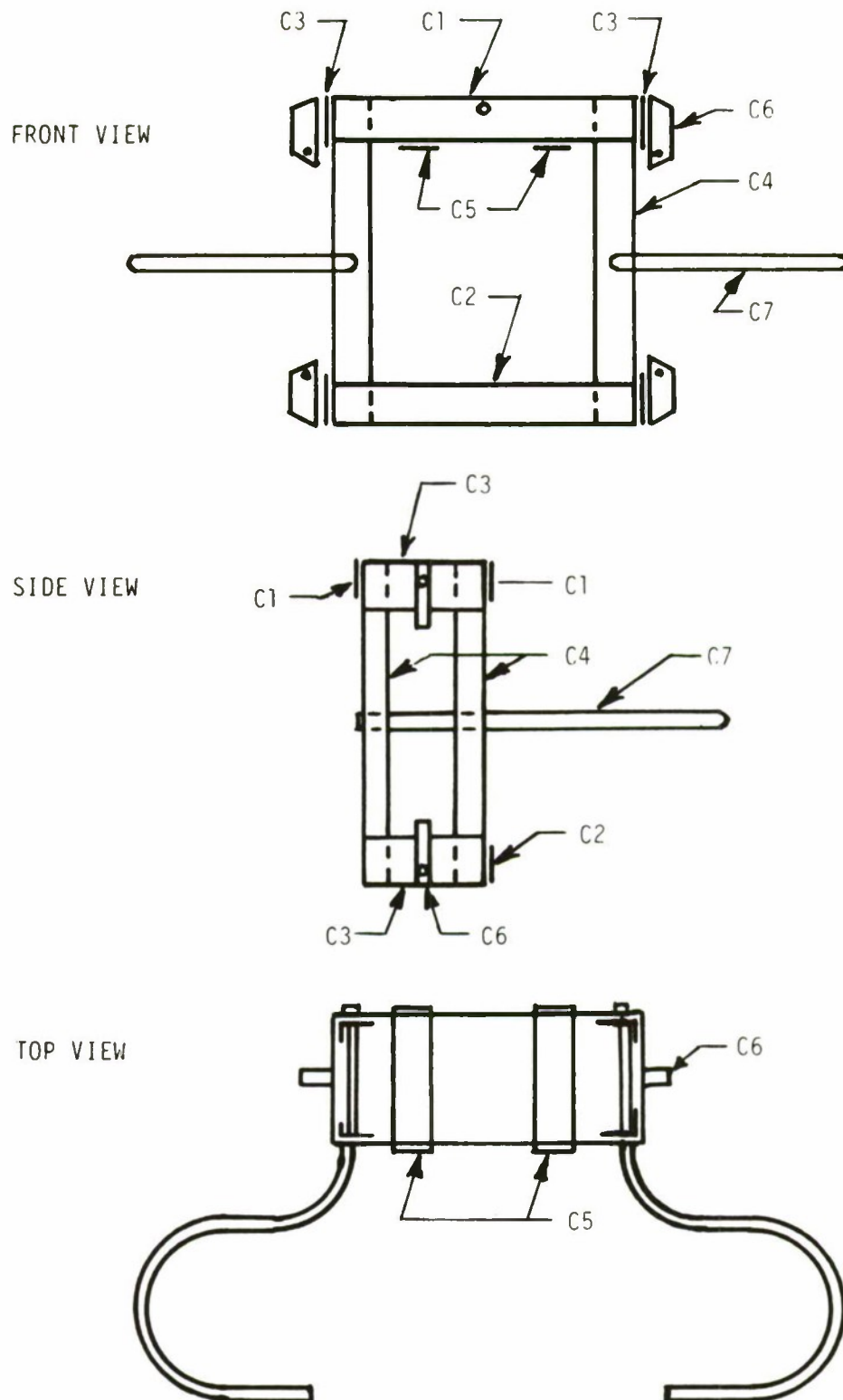


Figure 1. Welding of Carriage. Note: also consult the text for additional considerations.

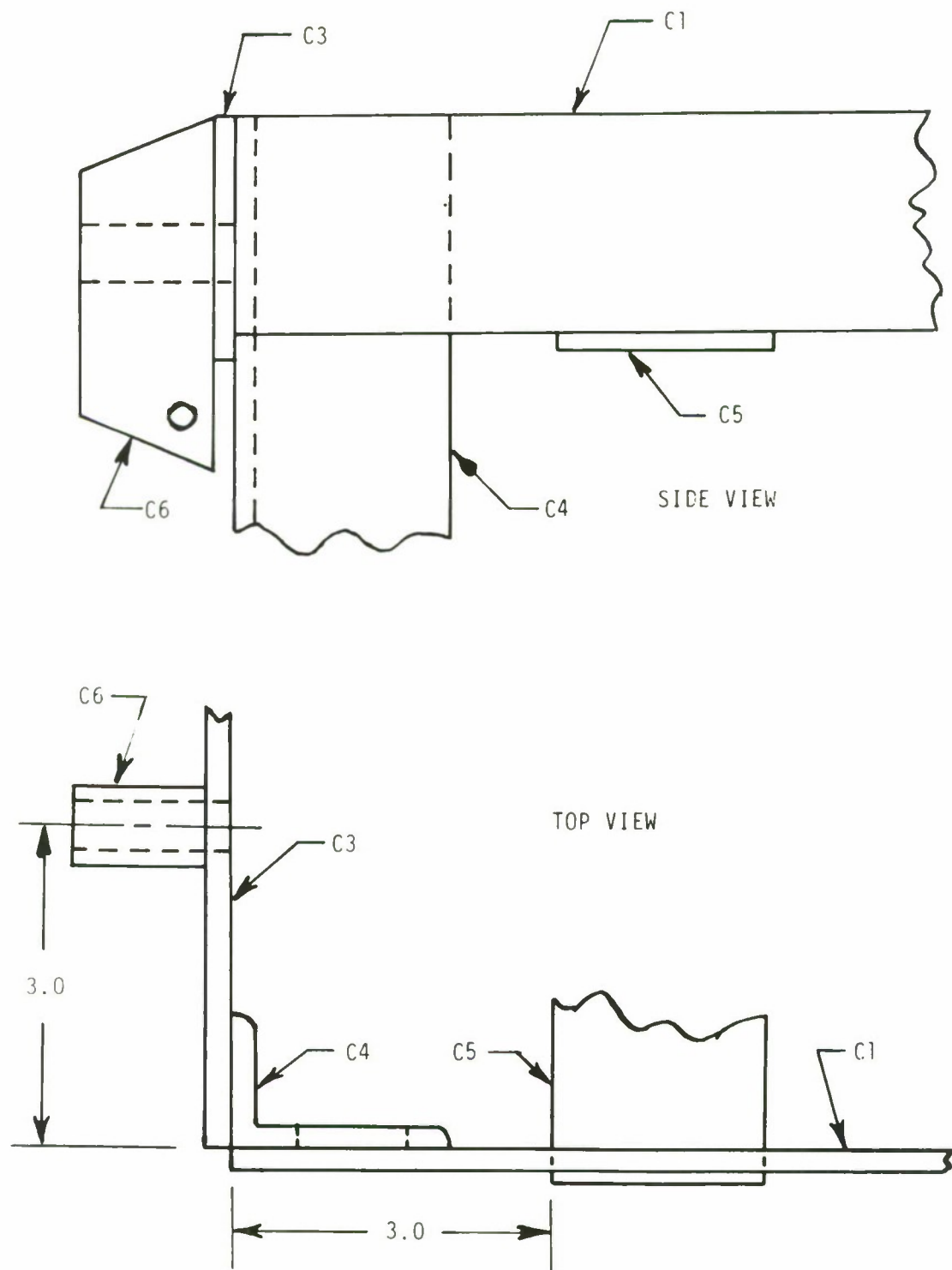


Figure 2. Carriage Welding Details.

bearings should be installed on the front side where the handles are (the subject's side). This will avoid the uneven welded spots on the main uprights and give a smooth operation of the carriage. The handles should be wrapped only after the carriage has been installed in the frame, which comes later. After complete assembly, weigh the carriage, the tongue, and the tongue bolt to insure that it weighs 40 pounds plus or minus one pound. If needed, pieces of metal may be added - inside the handles may be a good place, or on top of the support plates. An overweight condition is not anticipated, but if it occurs, some material may be removed from the back corner strips (C4), at the bottom where there is no bottom strip; or a thin strip may be removed from the support plates (C5).

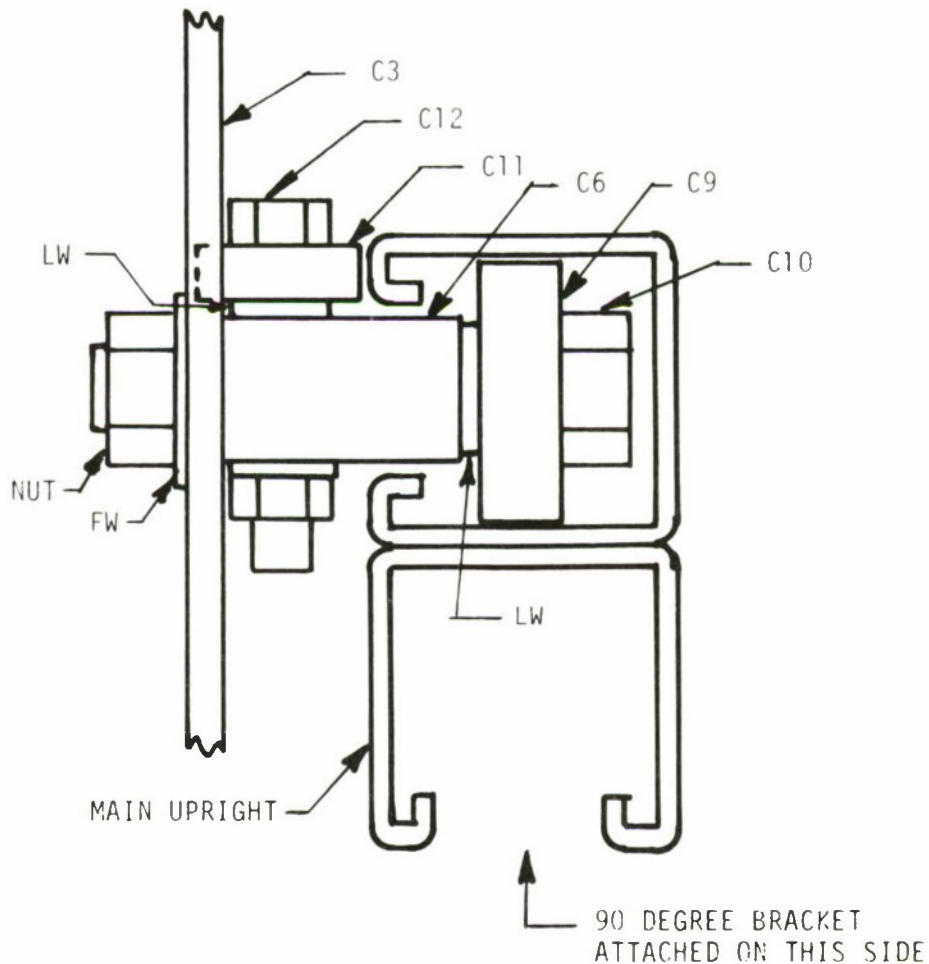


Figure 3. Installation of Bearings, Top View.

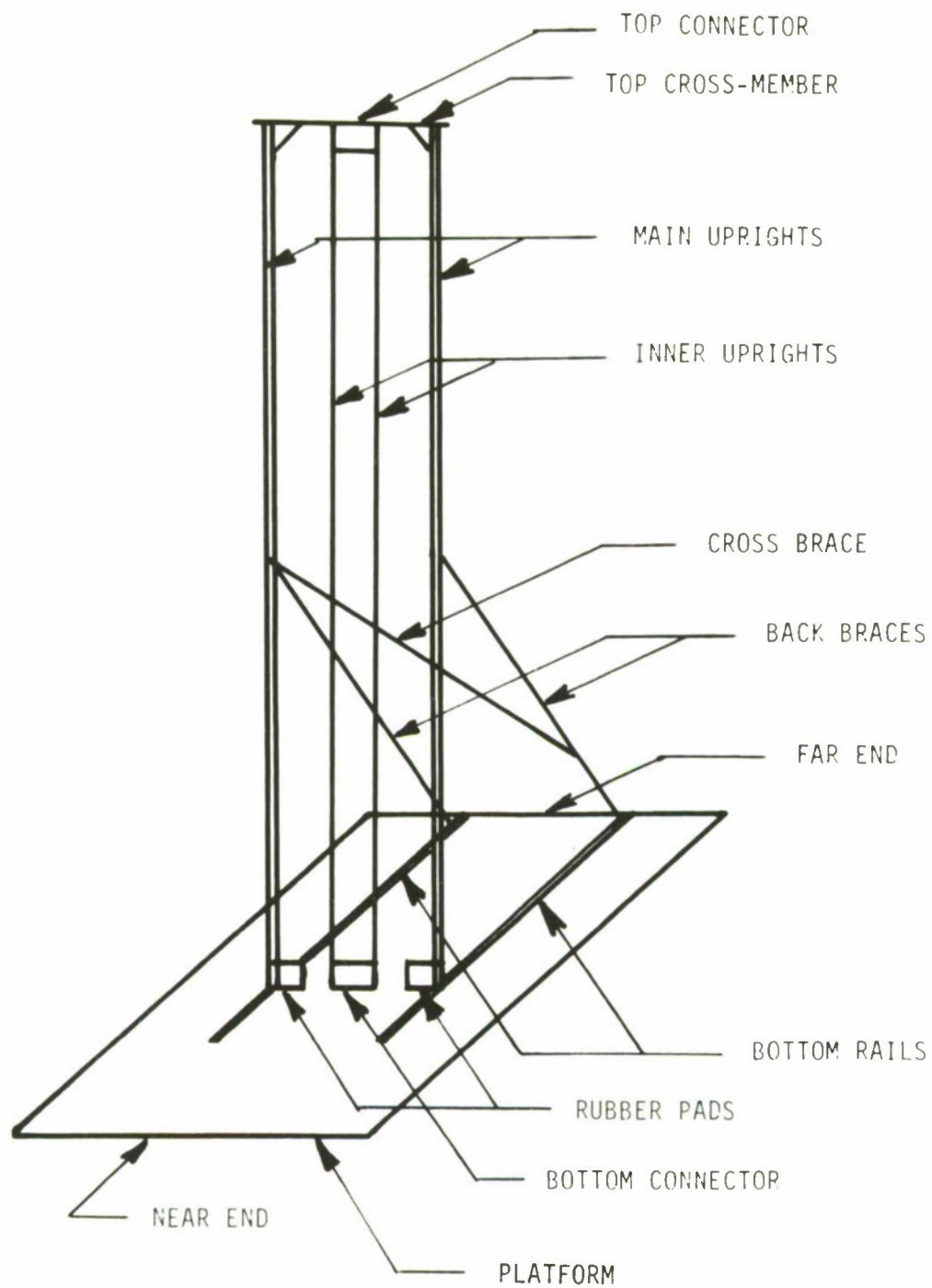


Figure 4. Sketch of the Frame of the Weight Lifting Machine.
Note: several features have been omitted for the sake of clarity.

4.2. Frame Assembly. A sketch of the assembled frame is given in Figure 4. This may be used for guidance as to where the individual components are located in relationship of one to another.

The initial step in the assembly of the frame is to glue the two plywood pieces together to form the platform. White glue, applied to both sides, is good. During drying, the plywood should be laid down on a flat floor and heavy weights should be placed on it. The 22 ten-pound weights will do. After the glue has set, prime and paint the platform. After final assembly a suitable piece of carpet may be installed for the subject to stand on.

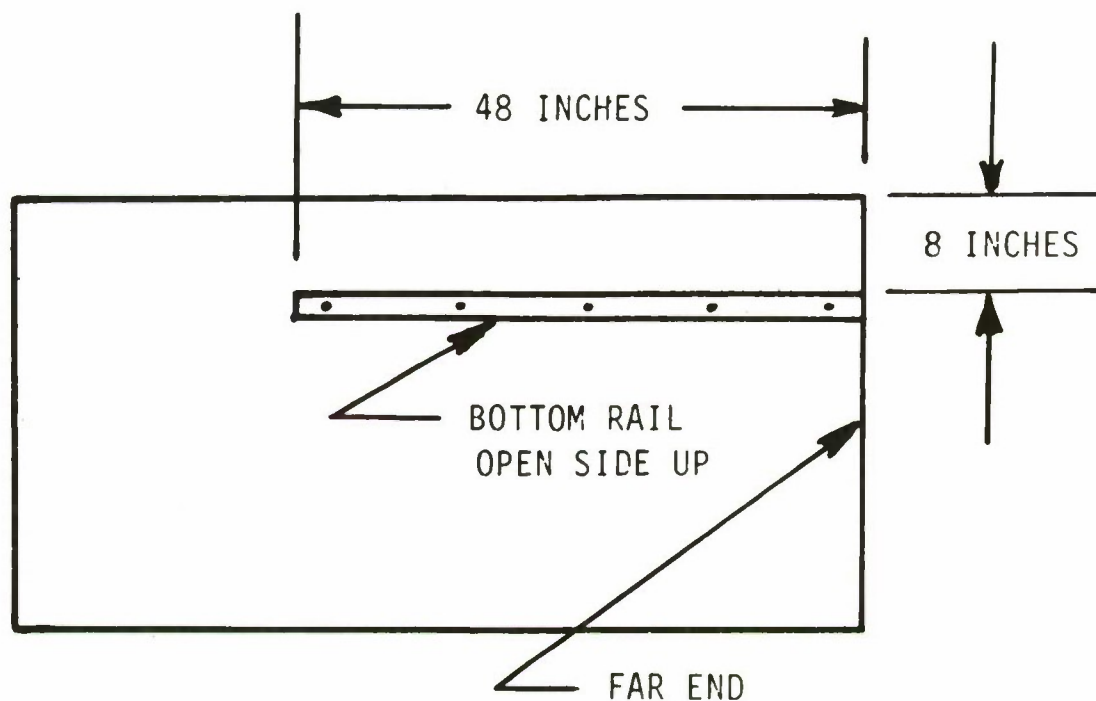


Figure 5. Installing the Bottom Rail.

Next, one of the bottom rails is installed on the platform. Position the rail so that one end is even with the end of the platform (this will be called the "far end" in the rest of this section) and so that the outside of the rail is 8 inches from the edge of the platform (see Figure 5). Using the 5 holes in the

rail as guides, drill 5 holes through the bottom plate. Countersink the holes from the other side to a sufficient depth so that the screw heads will not protrude out of the plywood. Install screws from the bottom and flat washers and nuts from the top side.

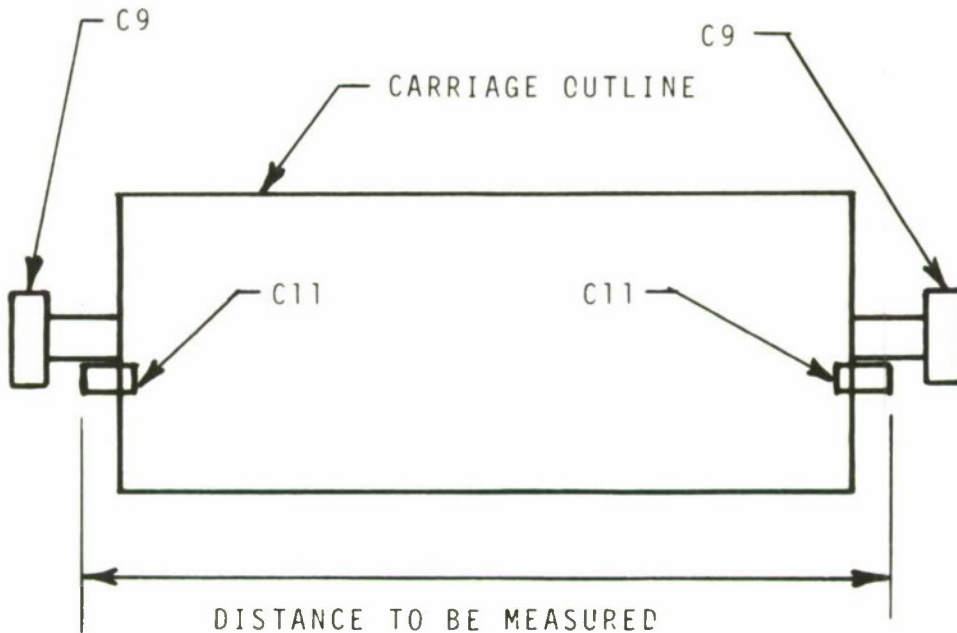


Figure 6. Measuring the Outside Distance over the Small Bearings.

The location of the other rail has to be adjusted to the carriage width. To accomplish this, measure the outside distance across the small bearings (C11) as shown in Figure 6. Do this for both the top and the bottom bearings. Select the larger of these two measurements and add 1/16 inch to it. This is the "required space". Position the second bottom rail on the platform so that there is the "required space" between the inside edges of the rails. Fasten the other bottom rail the same as the first. We recommend retightening the bolts after a few days.

Install the 90 degree gussets on the top cross-member (Figure 7),

so that the "required space" is between the surfaces labelled "attached to main uprights". Position the gussets so that there is approximately the same length of the top cross-member protruding on each end.

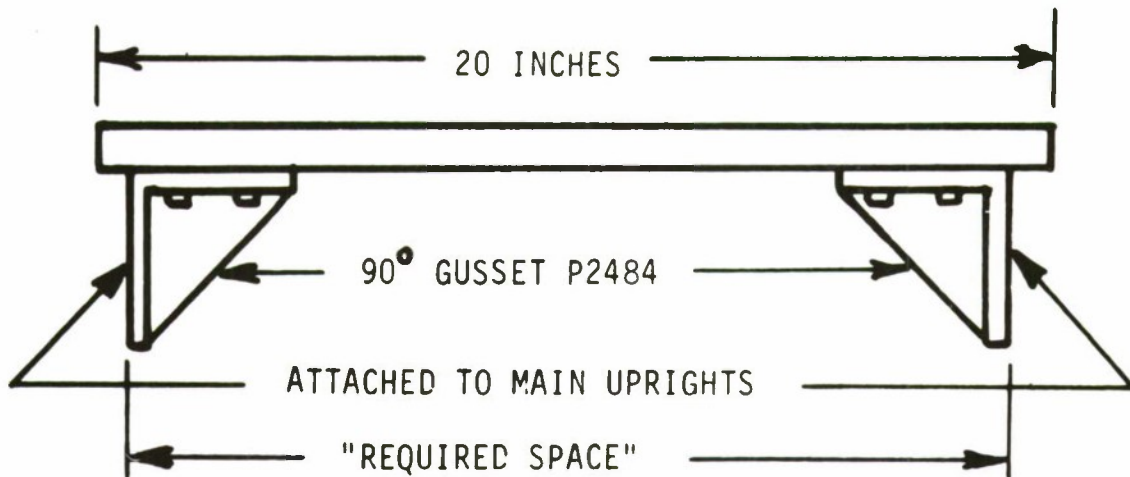


Figure 7. Installing Gussets on Top Cross-Member.

Attach (tightly) a 30 degree bracket to one end of each back brace and a 60 degree bracket to the other end of each back brace, as illustrated in Figure 8.

Assemble the top and the bottom connectors. The connector with the countersunk holes (F4) and the flat-head screws will be the bottom connector. Install the top connector in the center of the top cross-member.

Install the two 90 degree brackets on the bottom rails so that the bottom legs point toward the far end of the platform (see Figure 9). The upright leg of the bracket is to be 29 inches from the far end (note: measure and install one bracket. Position the other at a right angle across from the first).

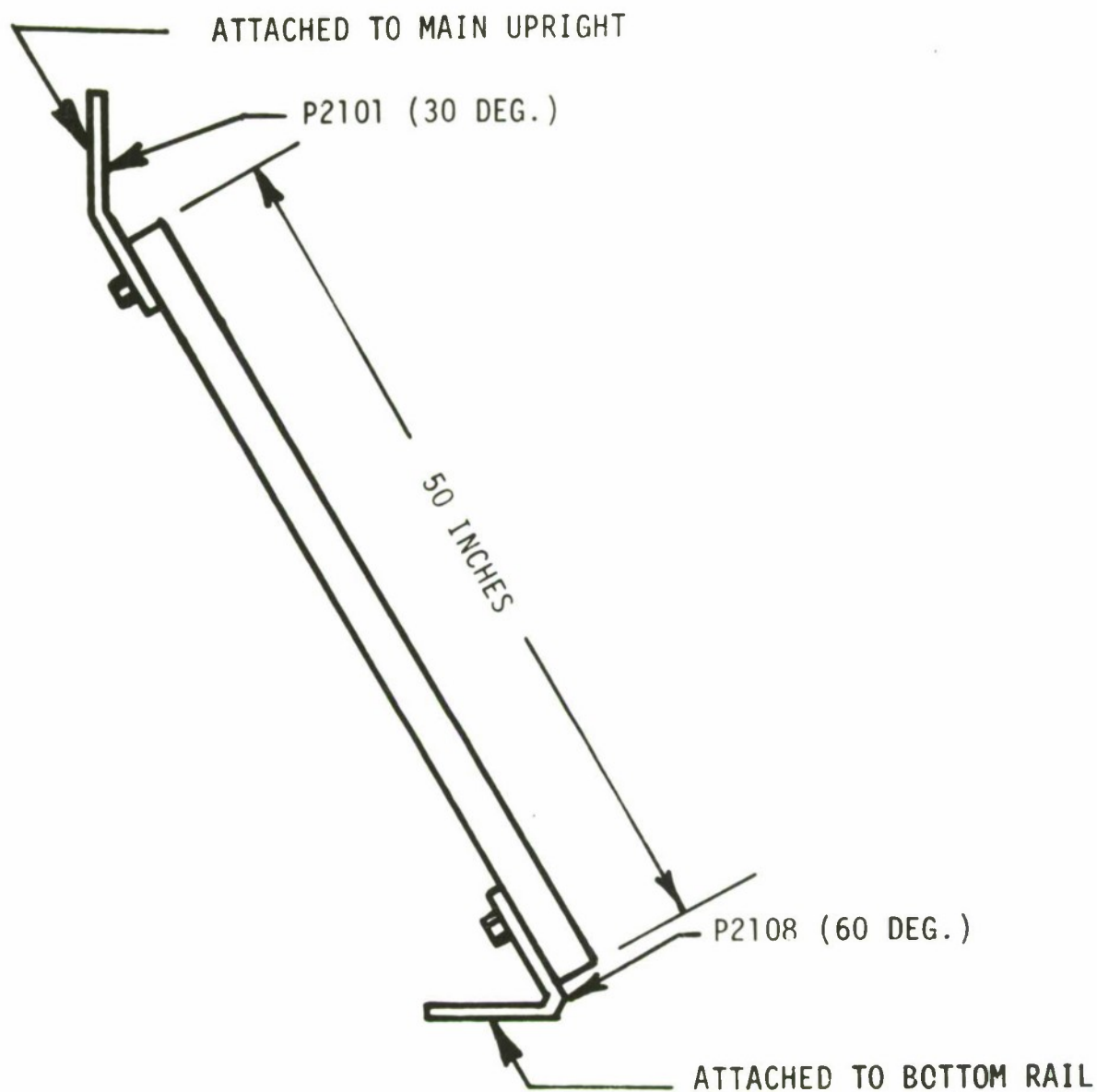


Figure 8. Installing Brackets on Back Braces.

Place a main upright against this bracket, and orient it as it will be when installed. Make a mark on the platform (between the two rails - see Figure 10) directly under the center of the inward facing channel in which the large bearings will travel. Do the same on the other side. Draw a straight line from mark to

mark. Measure (between the two bottom rails) and mark the center of this line. Using No. 8 pan-head sheet-metal screws, install the bottom connector, centered on the center of the line.

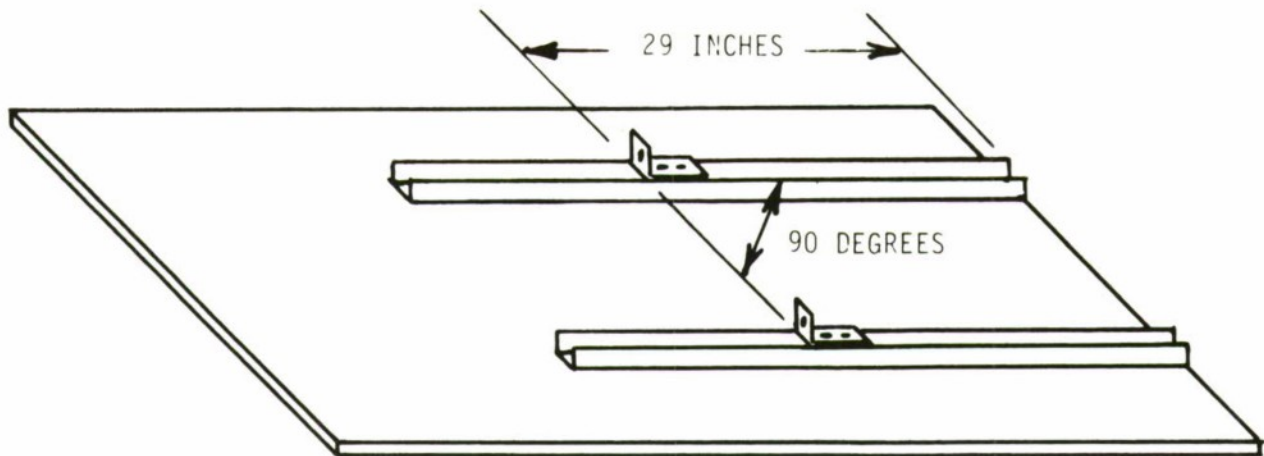


Figure 9. Installing 90 Degree Brackets on the Bottom Rails.

Using contact cement, bond together 4 rubber pieces into a stack. Make two such stacks. Place a weight (with the indented side toward the far end) over the bottom connector (F3/F4) and center the hole of the weight over the body of the connector. On the bottom plate, mark just to the outside of the dimples in the weights, and around the edges of the weight. Remove the weight and place the rubber stacks so that their inner edges are even with the dimple marks and so that they support the ends of the weight - check with a weight; it must not wobble on the dimples. Bond the rubber stacks to the bottom plate in that location.

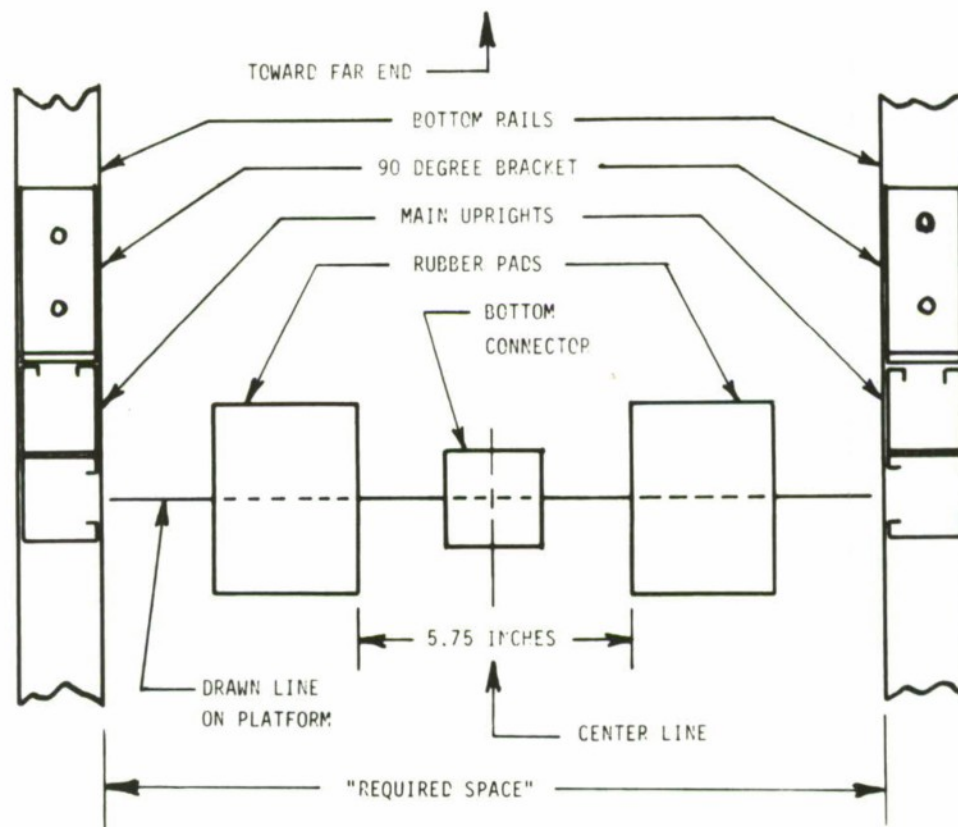


Figure 10. Arrangement of Components on Platform, Viewed from Above.

Preposition the Unistrut nuts in the main uprights where they will be attached to the 90 degree brackets on the bottom rails (Figure 10). Place the main uprights on the large bearings of the carriage. You may wish to use some support, or hold the carriage and the uprights at an angle, or whatever other method that is helpful. Also refer to Figure 4. Push the main uprights against the 90 degree brackets, install and tighten the screws. Install the back brackets so that they form 60 degrees with the

bottom rail. Before completely tightening the bottom screws, sight from one side and check that the main uprights are parallel - some adjusting is possible. Install and tighten the top cross-member. After tightening all screws well, slowly and carefully move the carriage up and down - it should move freely all the way up. If not, loosen the bolts near the binding point, and adjust the separation.

Install the cross-brace: one end of it goes on the bolt that holds the 30 degree bracket, and the other end is fastened with a separate bolt to the other brack brace (see Figure 4).

Drill holes ($7/32$ inch drill bit) for No. 10 screws in one end of each of the inner uprights, $3/8$ inches from the end. Place these ends on the body of the bottom connector (F3), and loosely install the screws. Place the top ends of the inner uprights against the top connector, and mark where the top ends should be cut off and drilled. Remove the inner uprights from the machine before performing any needed cutting and drilling, and check afterwards that the drilled holes are well aligned with the tapped holes in the connectors. Make corrections if necessary. Temporarily set the inner uprights aside.

Notice that some of the weights have plastic inserts in the holes. Take three weights with plastic inserts and label them with the letters H, Q, and Z (close to the hole for the weight select pin). Label thirteen weights without plastic inserts with the remaining letters as given in Appendix II, noting that the letters I, O, and Y are not used. We recommend using a stencil ($3/4$ or $7/8$ inch high letters) and white spray paint. Label the carriage itself with the letter G.

Take the weight with the letter Z and place it on the rubber bumpers with the indented side toward the far end. Check that its hole is well centered over the bottom connector. Then pile up the remaining 15 weights so that the stack of weights is

marked in alphabetical order, starting at the top and going to the bottom.

Being careful not to upset the stack, insert the inner uprights through the holes in the weights, and fasten the screws at both ends. Install the tongue between the inner uprights and insert the large bolt for holding the tongue. Either sight or use the weight select pin to check the alignment of holes in the tongue with those between the weights. If needed, the bolt hole in the tongue may be elongated upward to lower the tongue; or thin pieces of rubber (such as inner tubes) may be bonded to the top weight to raise the tongue.

When satisfied with the alignment, install the tongue spacer as follows: with the carriage resting on the weights, position the tongue along the bolt so that it is centered within the inner uprights. Then cut off two pieces from copper tubing such that one piece fits in front of the tongue (between the tongue and the inside of the top strip) and the other behind it, allowing 1/16 to 1/8 inch clearance. Place these spacers on the bolt and install the self-locking nut. Tighten the nut until it touches the carriage body but not any further, as then you can easily distort the body of the carriage.

Wrap the handles with tape. We recommend starting the wrap from the free end of the handle, so that the tape extends slightly over the end itself (this provides a padded handle end), and overlapping the windings about one third. Six inches or more of the handle should be wrapped. Secure the free end of the tape with string (whipping), or plastic cable ties (used by electricians).

Unless it already has been done, install the cover (C18) on the carriage.

We also recommend installing (painting or pressure sensitive

tape) clearly visible markings on both main uprights (so it can be seen from both sides) at 6 feet above the platform so that the examiner can easily determine that the handles have been lifted to 6 feet.

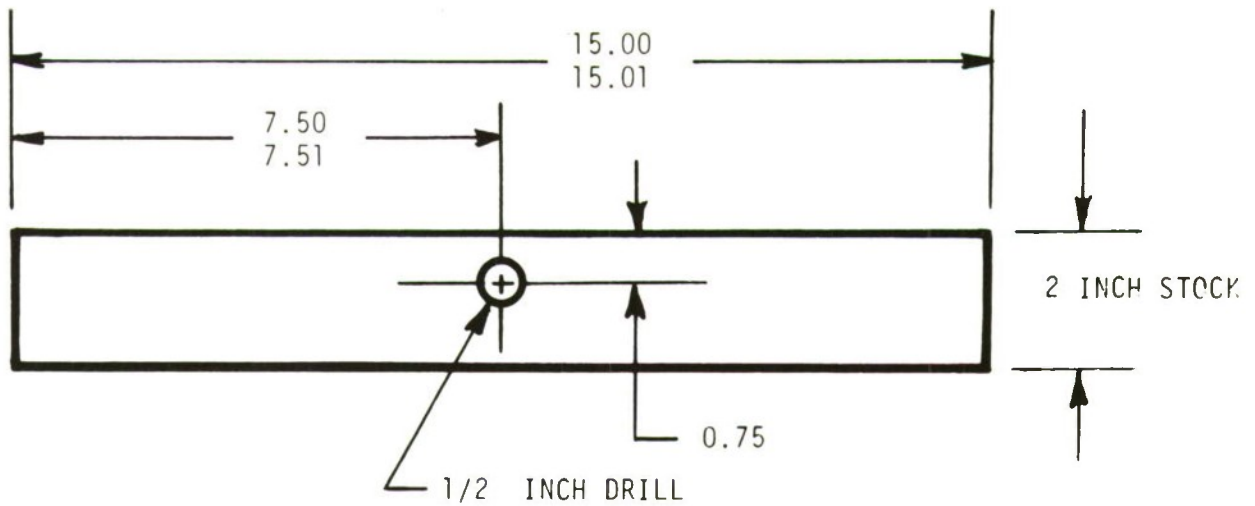
The machine is now ready. We recommend retightening all screws after the machine has been used for some time, particularly those holding the bottom rails to the platform.

The testing procedures are contained in MEPCOM Regulation No. 40-3. While we have provided some extracts of a proposed (at the time of this writing) version of this regulation, personnel accomplishing the testing must obtain a current version and use that in the actual tests.

APPENDIX I

This appendix contains the drawings for those parts that have to be fabricated by a machine shop. Parts belonging to the carriage are prefixed with a "C", and parts belonging to the frame are prefixed with an "F".

PART C1: TOP STRIPS.

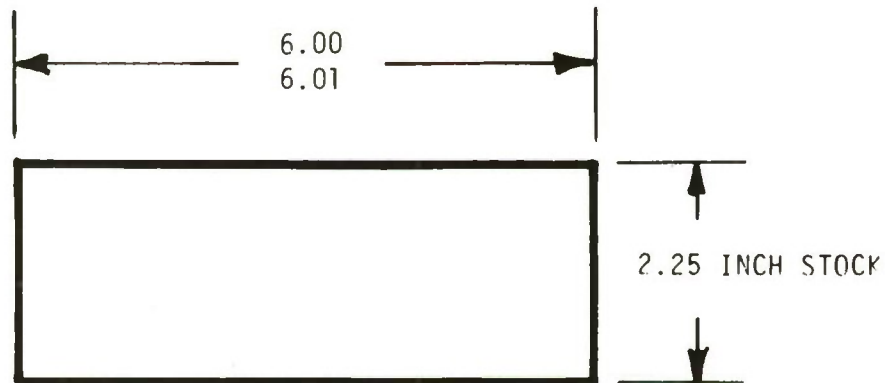


MATERIAL: 2 INCH X 3/16 INCH STEEL. QUANTITY: 2.

NOTE: For Part C2, Bottom Strip, omit the 1/2 inch hole.
Quantity: 1.

Figure A1. Top and Bottom Strips.

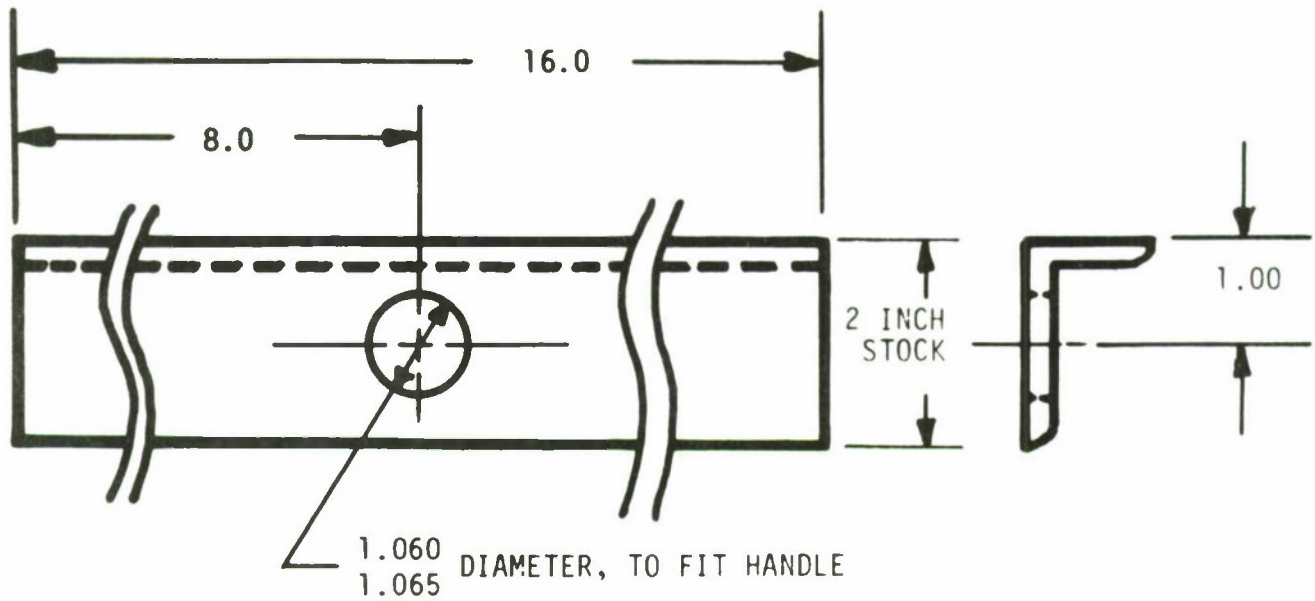
PART C3: SIDE STRIPS.



MATERIAL: 2 1/4 INCH X 3/16 INCH STEEL. QUANTITY: 4.

Figure A2. Side Strips.

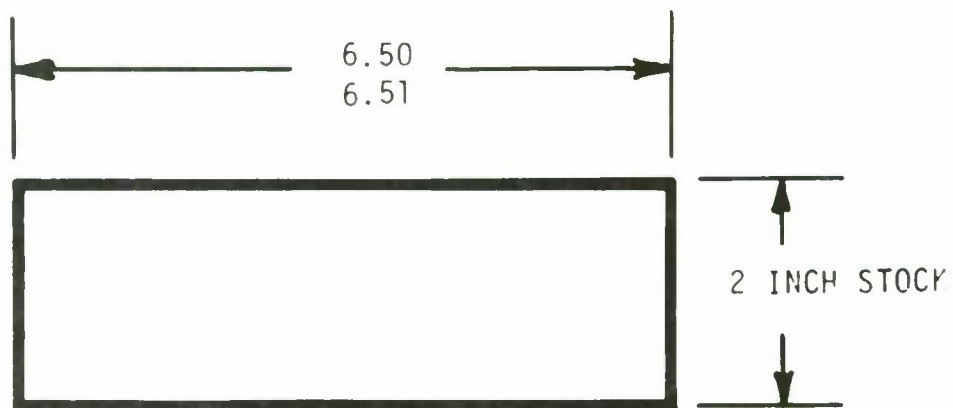
PART C4: CORNER STRIPS.



MATERIAL: 2 INCH X 1 1/4 INCH X 3/16 INCH HOT ROLLED ANGLE.
QUANTITY: 4.

Figure A3. Corner Strips.

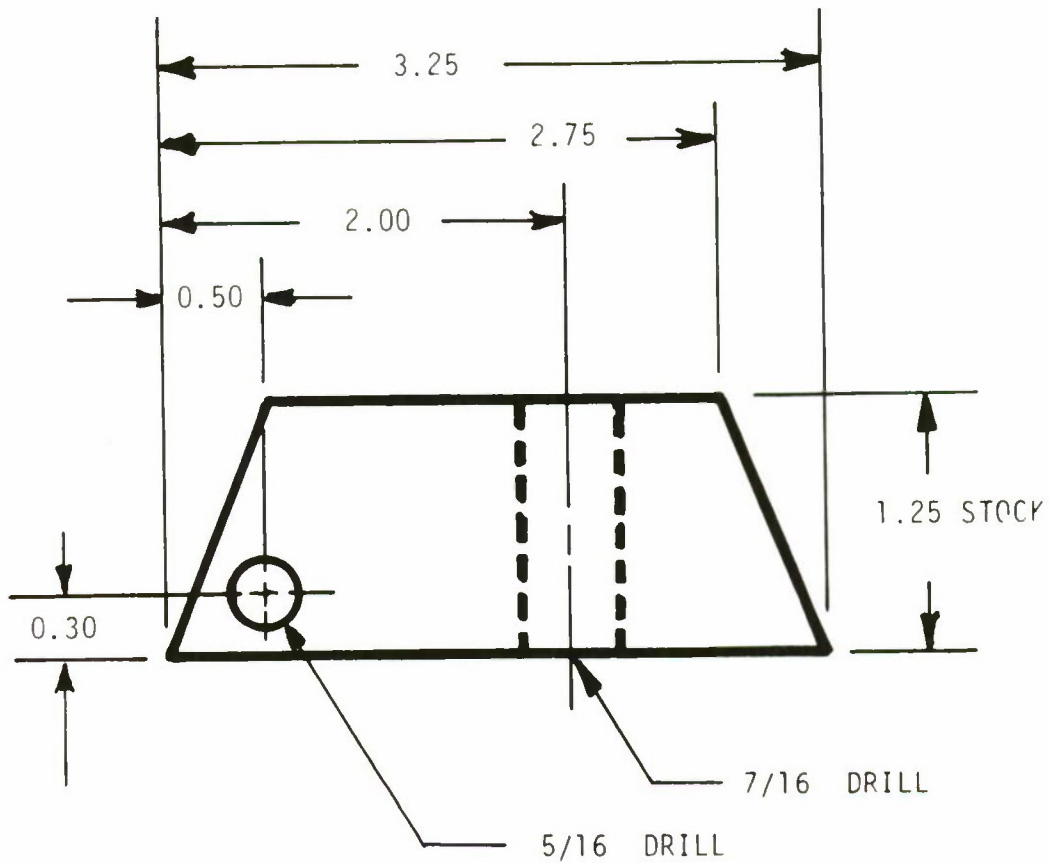
PART C5: SUPPORT PLATES.



MATERIAL: 2 INCH X 1/8 INCH STEEL. QUANTITY: 2.

Figure A4. Support Plates.

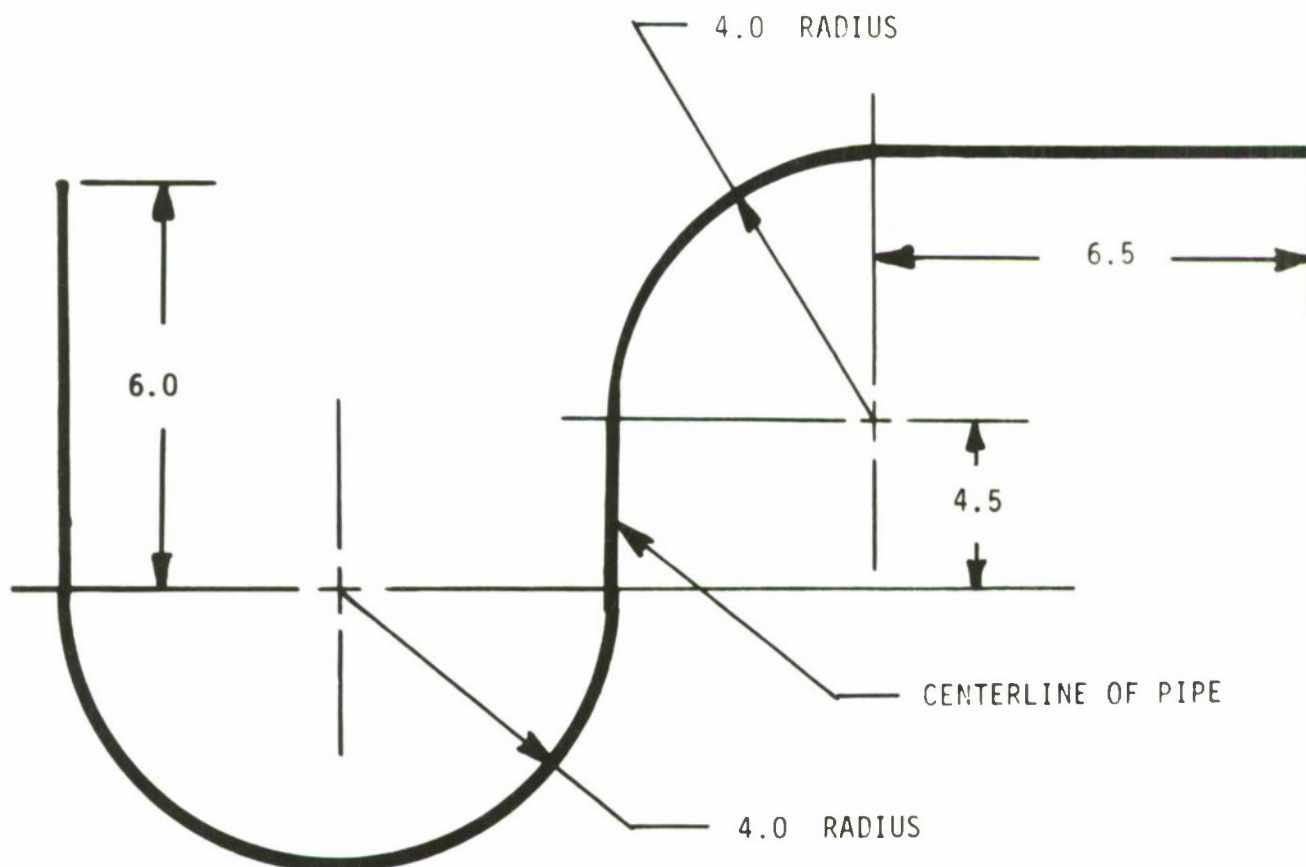
PART C6: BEARING HOLDERS.



MATERIAL: 3/4 INCH THICK HOT ROLLED STEEL. QUANTITY: 4.

Figure A5. Bearing Holders.

PART C7: HANDLES.

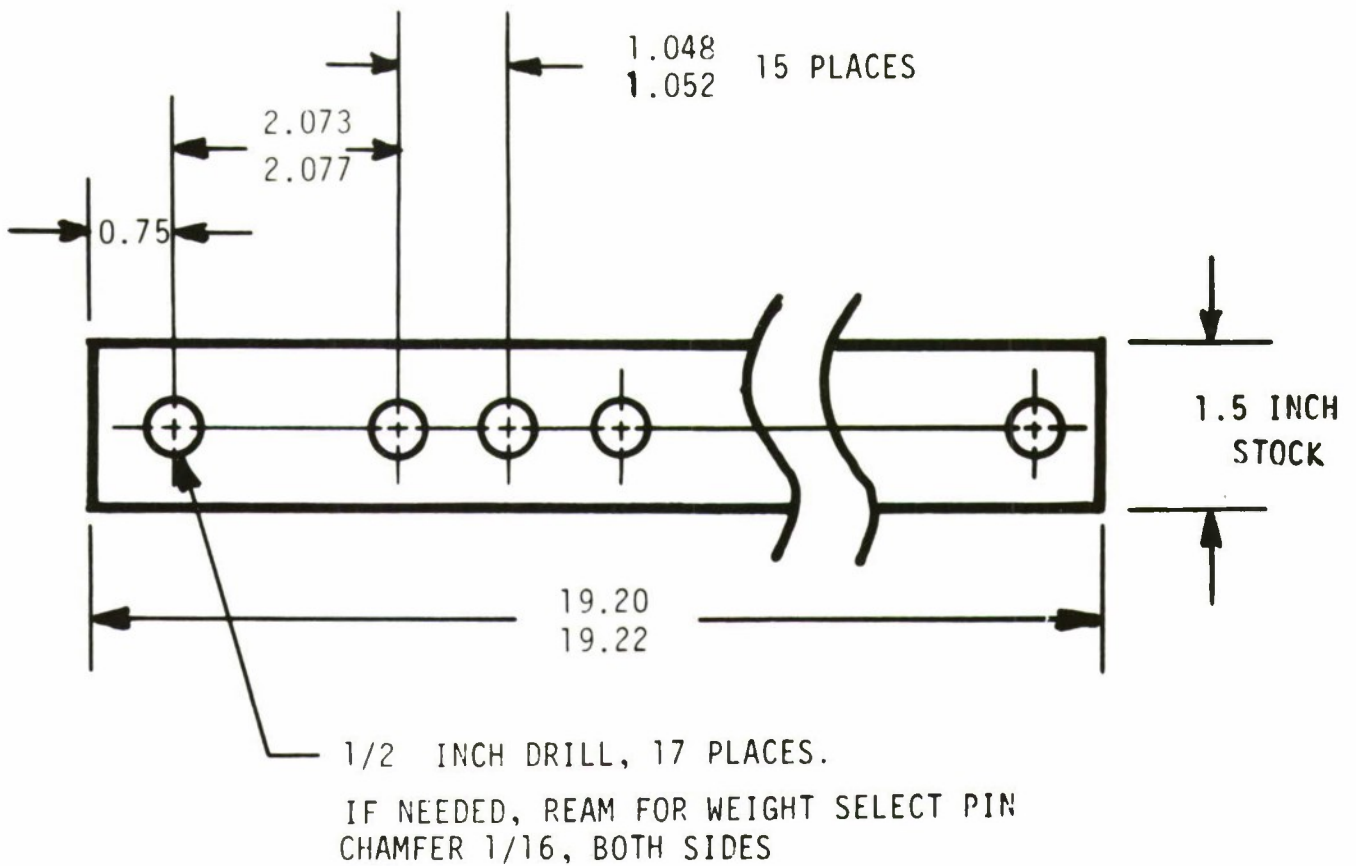


MATERIAL: 3/4 INCH STANDARD BLACK PIPE (ACTUAL O.D. = 1.050 INCHES). QUANTITY: 2.

Note: Some dimensions are not to scale.

Figure A6. Handles.

PART C8: TONGUE.

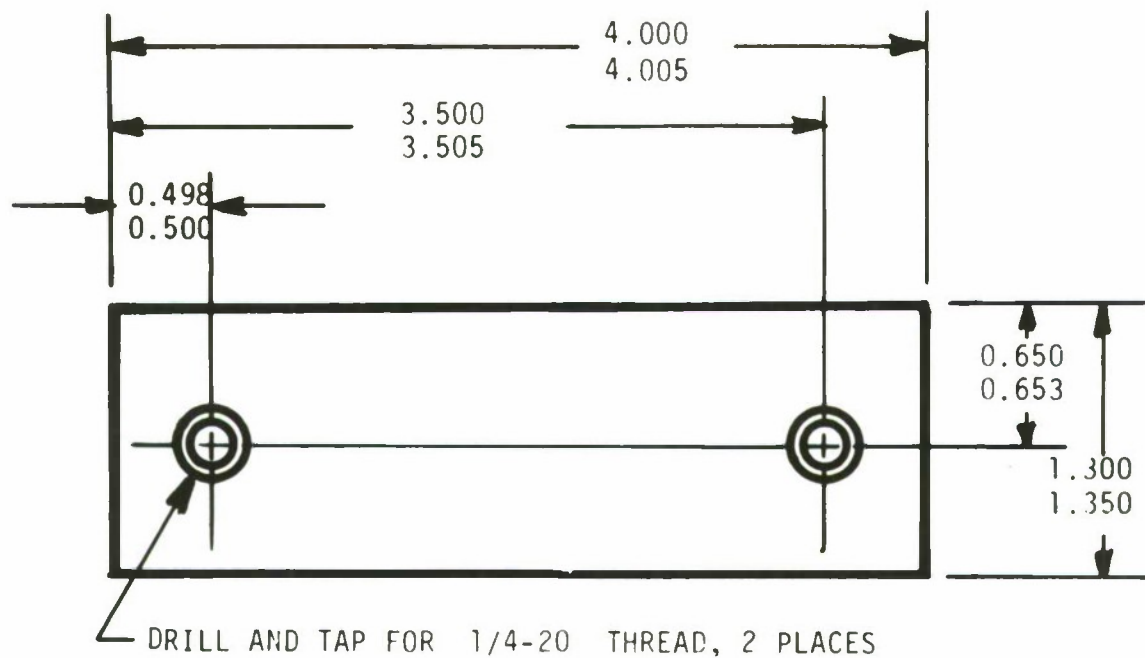


MATERIAL: 1 1/2 INCH X 1/8 INCH STEEL. QUANTITY: 1.

Note: Check the edges of the tongue; they must be smooth.
File, sand or grind if needed.

Figure A7. Tongue.

PART F1: CHANNEL PLATE OF TOP CONNECTOR.

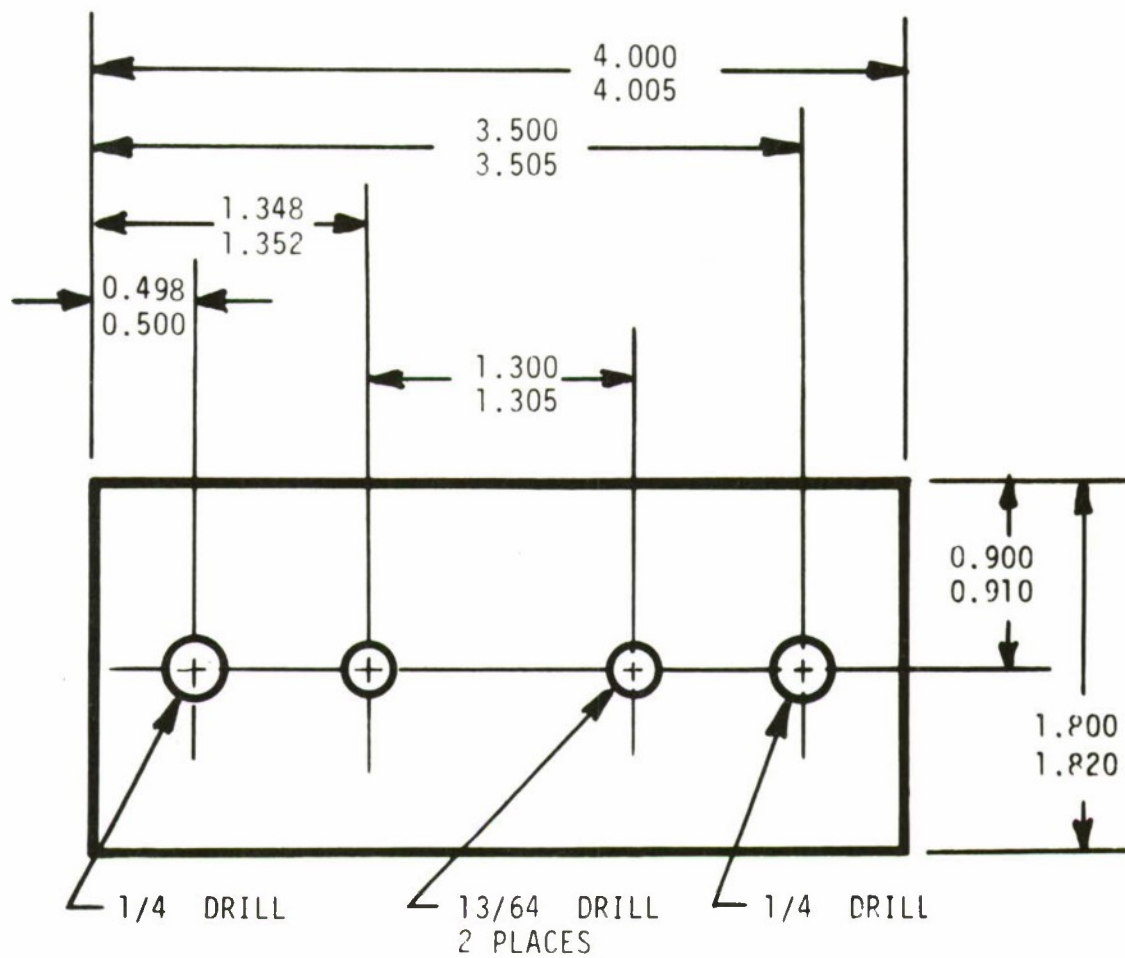


MATERIAL: 5/16 INCH THICK HARD ALUMINUM.

QUANTITY: 1.

Figure A8. Channel Plate of Top Connector.

PART F2: TOP CONNECTOR PLATE.

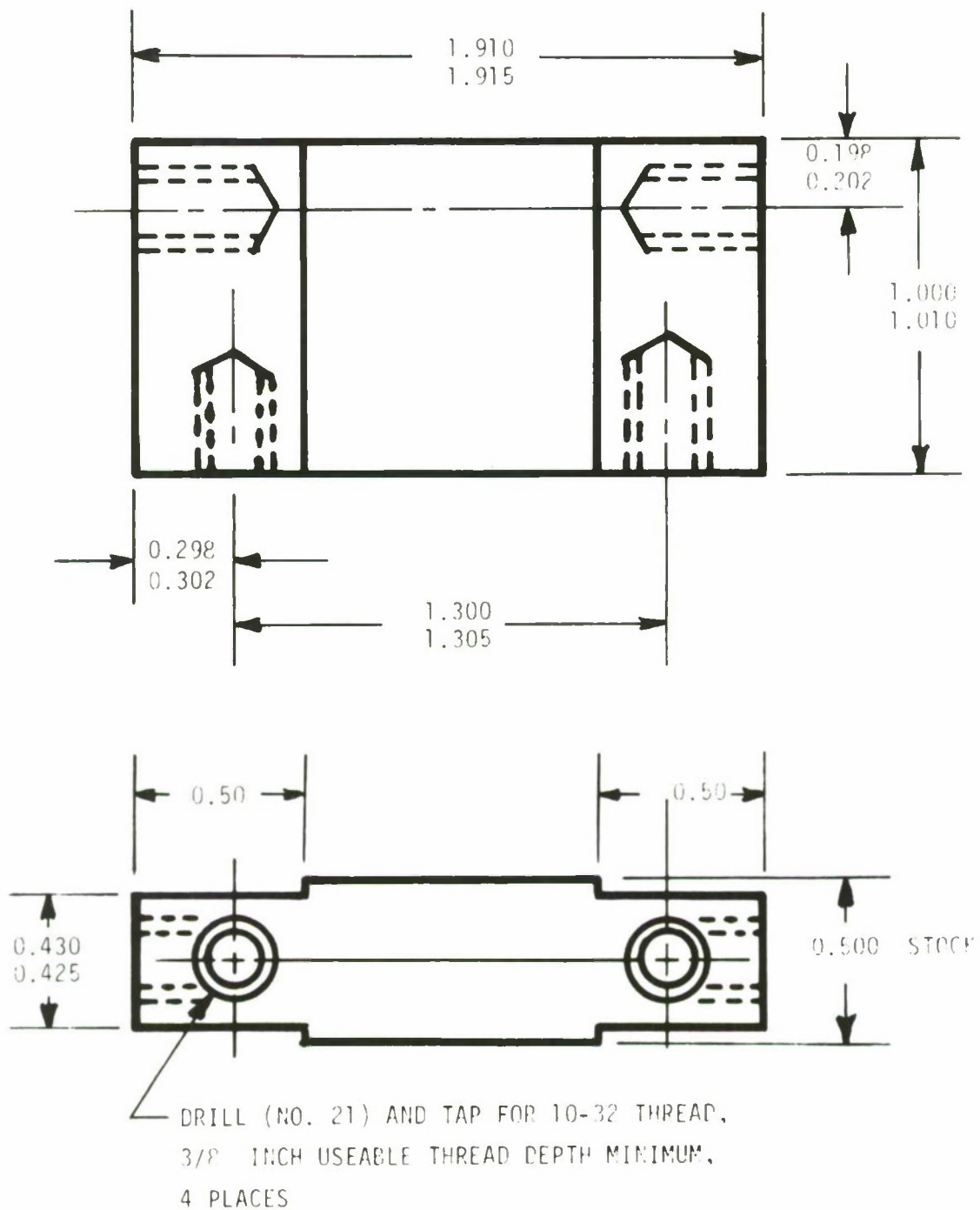


MATERIAL: 3/16 INCH THICK HARD ALUMINUM.

QUANTITY: 1.

Figure A9. Top Connector Plate.

PART F3: CONNECTOR BODY.

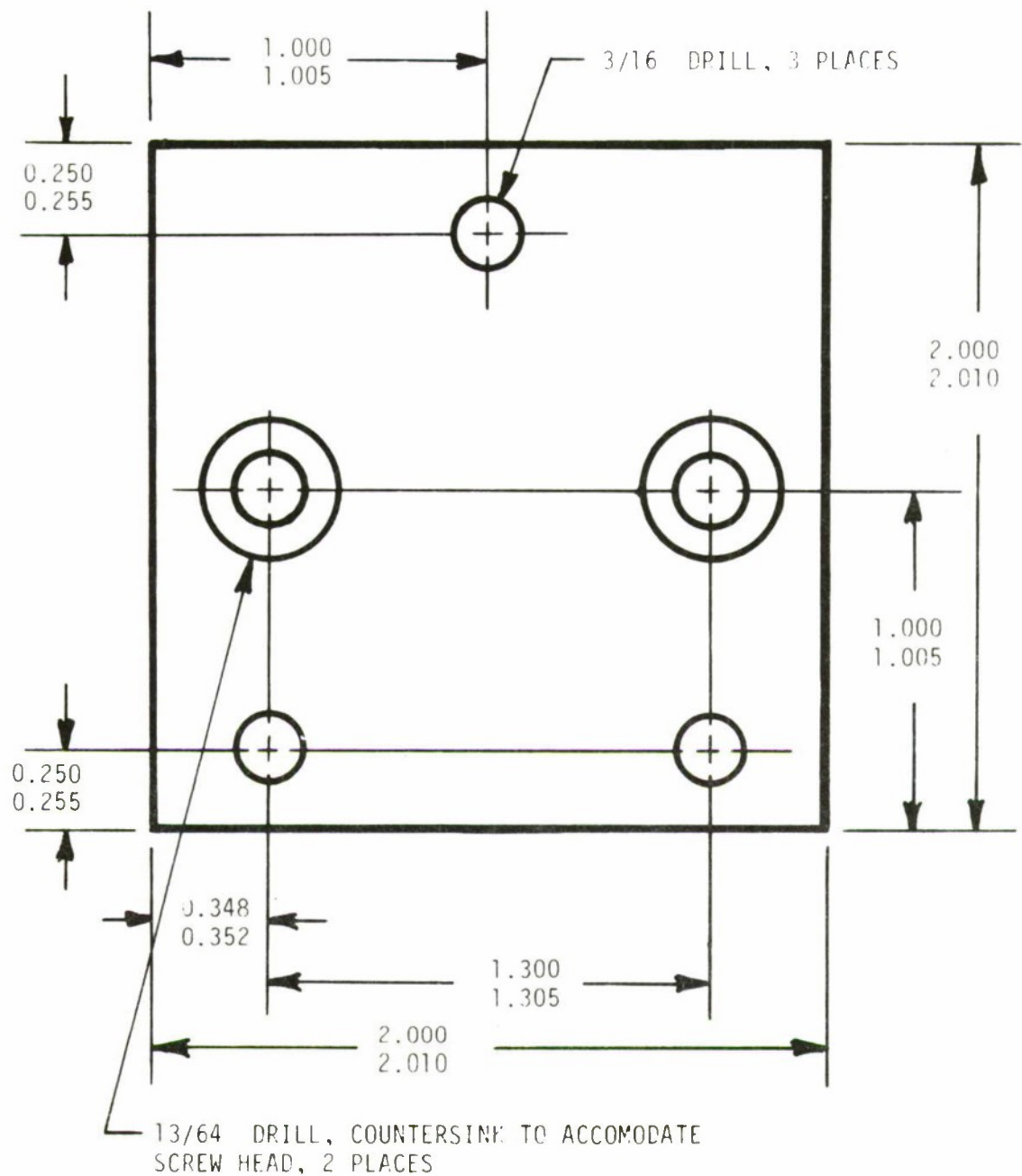


MATERIAL: 1/2 INCH THICK HARD ALUMINUM.

QUANTITY: 2.

Figure A10. Connector Body.

PART F4: BOTTOM CONNECTOR PLATE.



MATERIAL: 3/16 INCH THICK HARD ALUMINUM. QUANTITY: 1.

Figure All. Bottom Connector Plate.

APPENDIX II

* * * * *

NOTE: This appendix is provided for convenience only. For actual testing, a current version of this regulation (or other applicable authority) must be obtained and used. Also note that this is a proposed version; the currently used version prescribes lifting 40 pounds, 70 pounds and 100 pounds. The proposed version prescribes lifting weights starting at 40 pounds and incrementing the weight in 10 pound increments until no more weights can be lifted.

* * * * *

Extracts from MEPCOM Regulation No. 40-3 (Proposed).

PURPOSE. This regulation prescribes procedures for strength testing of Air Force recruits in the Military Enlistment Processing Stations (MEPS).

TEST PROCEDURES. Testing will be accomplished after the cardiovascular / orthopedic examination has been completed and the SF 93 has been reviewed. Each applicant will be questioned about any medical defect or condition that may preclude completion of the test. Applicants with a history of back problems, back strains, recurrent shoulder dislocations, or any other condition that could affect them adversely in lifting weights should be categorized as temporarily disqualified or permanently disqualified from military service or cleared for further processing prior to the weight lift test. Any questionable cases cleared for the weight-lift test will be supervised by the medical officer during the testing. Should previously concealed information be obtained from the applicant at the time of testing, the Chief Medical Officer will be informed and will decide if testing should be accomplished.

a. Individuals will be tested during separate male/female physical examinations.

b. Examinees will be tested without shoes and should not wear jackets or coats, or other articles of clothing which might restrict the examinee's mobility while performing the test.

c. Each group of examinees will be given the briefing. This briefing will be read verbatim:

Gentlemen/Ladies, the next step in your examination is to test your physical strength. This test is a requirement for enlistment in the Air Force to assure that you are not placed into a job or skill which might require strength beyond your capability. You should attempt to raise the maximum amount of weight possible as you would then qualify for the greatest number of skills.

This is a test of your ability to lift weights. First you will lift a medium weight to six feet. After each successful lift, the weight will be increased, and you will try again. If you are unable to lift any weight, I will ask you to stop. If you feel you cannot safely attempt a heavier weight, just say: "I want to stop".

Before you lift the weights, the correct lifting method will be demonstrated. The key points to remember are these:

1. Grasp the handle as instructed: palm down, hand on top of handle.
2. Take a deep breath and hold it while you are lifting.
3. Start with your arms straight at the elbow.

4. Bend your knees slightly and keep your back as erect as possible.

5. Lift the handle as smoothly and rapidly as comfortable for you; do not try to jerk the handle at the beginning of the lift.

6. Lower the weights slowly and resume normal breathing.

If any of you have a history of back injury, back strain, recurrent shoulder dislocations, or any other condition that you think could affect you in lifting this weight, please step forward and I will refer you to the Chief Medical Officer to determine if you should be tested.

Are there any questions? Now, observe the demonstrations.

(Notice to the examiner: Take care not to record a weight that the examinee did not successfully lift, but rather the value of the last successful lift.)

At the conclusion of the briefing, the correct lifting technique will be demonstrated with the following points emphasized:

- (1) Place feet approximately shoulder width apart.
- (2) Take a deep breath and hold it during the entire lift.
- (3) Start with the arms straight at the elbow.
- (4) Bend the knees slightly and keep the back as erect as possible.
- (5) Do not jerk the handles at the beginning of the lift.

(6) Lift the weight as rapidly and comfortably as possible.

(7) Lower the weights slowly and resume normal breathing.

The purpose of the Incremental Weight Lift Test is to measure maximum safe weight lift capability. The examiner selects the first weight (carriage only) and instructs the examinee to assume the proper starting position: overhand grip with palms down, arms straight, knees bent, body as vertical as possible. The examinee then raises the handles to a height of six feet or more above the standing surface. As soon as the examiner verifies that the handles were at or above six feet, the examinee is instructed to lower the handles. (Note: recruits meeting the 60 inch minimum stature requirement can raise the handles to a height of six feet. Shorter people with height waivers will be given a passing score if they are able to raise the handles above their head and with their arms fully extended.) If the examinee fails to raise the "G" (top) weight as required, enter a score of "F".

The weight is then increased to the "H" weight and the examinee attempts to raise the handles again. The test is continued in this manner, adding one weight at each attempt until: (1) the examinee elects to stop, (2) the examinee is unable to raise the weight to six feet or full extension, or (3) the examinee successfully lifts all of the test weights. If the examinee attempted but failed to raise a weight to six feet, the value of the previous successful lift is recorded as the examinee's maximum safe lift capability to six feet.

Except in such rare cases where the examinee's grip slips and he or she performed a faulty lift for reasons other than lack of strength, examinees should not be allowed a second attempt to lift any weight during a single test session, except in accordance with paragraph "SAFETY PRECAUTIONS". Although, in many cases, a second attempt would have been successful, limiting

the test to one attempt eliminates such variables as overmotivation and technique.

The examinees should not be told how much weight they have lifted, what the starting level is, or the weight of the increments. Knowledge of results is withheld to prevent the examinees from competing with one another and to prevent overmotivation on the part of individual examinees. They can learn their scores later, during discussions with appropriate personnel.

SAFETY PRECAUTIONS. The following safety precautions will be followed in all cases. Deviations/exceptions from these precautions are not authorized.

a. Applicants will not attempt to lift any weight, other than the first, unless the previous lift was completely successful and performed according to the instructions.

b. Applicants able to lift a weight above elbow height but not to the height of six feet (or maximum reach height) on the first attempt will be allowed one additional attempt on that day (a maximum of two attempts on any one day) if the applicant so desires.

c. Applicants unable to lift any weight above elbow height will not be allowed a second attempt at that weight or any larger weight.

d. If the applicant raises a weight part-way and pauses for more than one second, instruct the applicant to lower the weight. Depending on items b or c above, continue or stop the test.

WEIGHT CODING. To simplify data keeping requirements the following alphabetic codes are proposed:

Weight	Code	Weight	Code	Weight	Code
<40	F	90	M	150	T
40	G	100	N	160	U
50	H	110	P	170	V
60	J	120	Q	180	W
70	K	130	R	190	X
80	L	140	S	200	Z

The letter F represents a failing score (failed to lift 40 pounds). Letters I and O are excluded because they can be confused with numerals. The letter Y is used to indicate missing data.